DESCRIPTION

RECORDING MEDIUM HAVING DATA STRUCTURE FOR MANAGING RANDOM/SHUFFLE REPRODUCTION OF VIDEO DATA RECORDED THEREON AND RECORDING AND REPRODUCING METHODS AND APPARATUSES

1. TECHNICAL FIELD

The present invention relates to a recording medium having a data structure for managing reproduction of at least video data recorded thereon as well as methods and apparatuses for reproduction and recording.

2. BACKGROUND ART

The standardization of new high-density read only and rewritable optical disks capable of recording large amounts of high-quality video and audio data has been progressing rapidly and new optical disk related products are expected to be commercially available on the market in the near future. The Blu-ray Disc Rewritable (BD-RW) is one example of these new optical disks.

Fig. 1 illustrates the file structure of the BD-RW. The file structure or data structure provides for managing the reproduction of the video and audio data recorded on the BD-RW. As shown, the data structure includes a root directory that contains at least one BDAV directory. The BDAV directory includes files such as 'info.bdav', 'menu.tidx', and 'mark.tidx', a PLAYLIST subdirectory in which playlist files (*.rpls and *.vpls) are stored, a CLIPINF subdirectory in which clip information files (*.clpi) are stored, and a STREAM subdirectory in which MPEG2-formatted A/V stream clip files (*.m2ts) corresponding to the clip information files are stored. In addition to illustrating the data structure of the optical disk, Fig. 1 represents the areas of the optical disk. For

example, the general information file info.bdav is stored in a general information area or areas on the optical disk.

Because the BD-RW data structure and disk format as illustrated in Fig. 1 is well-known and readily available, only a brief overview of the file structure will be provided in this disclosure.

As alluded to above, the STREAM directory includes MPEG2-formatted A/V stream files called clips. The STREAM directory may also include a special type of clip referred to as a bridge-clip A/V stream file. A bridge-clip is used for making seamless connection between two or more presentation intervals selected in the clips, and generally have a small data size compared to the clips.

The CLIPINF directory includes a clip information file associated with each A/V stream file. The clip information file indicates, among other things, the type of A/V stream associated therewith, number of source packets in the A/V stream associated therewith, and timing information of the source packets in the A/V stream associated therewith (e.g., on an arrival time basis (ATC) and/or a system time basis (STC)).

The PLAYLIST directory includes one or more playlist files. The concept of a playlist has been introduced to promote ease of editing/assembling clips for playback. A playlist file is a collection of playing intervals in the clips. Each playing interval is referred to as a playitem. The playlist file, among other things, identifies each playitem forming the playlist, and each playitem, among other things, is a pair of IN-point and OUT-point that point to positions on a time axis of the clip (e.g., ATC or STC basis). Expressed another way, the playlist file identifies playitems, each playitem points to a clip or portion thereof and identifies the clip file associated with the clip.

A playlist directory may include real playlists (*.rpls) and virtual playlists (*.vpls). A real playlist can only use clips and not bridge-clips. Namely, the real playlist is considered as referring to parts of clips, and therefore, conceptually considered equivalent in disk space to the referred to parts of the clips. A

virtual playlist can use both clips and bridge-clips, and therefore, the conceptual considerations of a real playlist do not exist with virtual playlists.

The info.bdav file is a general information file that provides general information for managing the reproduction of the A/V stream recorded on the optical disk. More specifically, the info.bdav file includes, among other things, a table of playlists that identifies the files names of the playlist in the PLAYLIST directory of the same BDAV directory.

The menu.tidx, menu.tdt1 and menu.tdt2 files store information related to menu thumbnails. The mark.tidx, mark.tdt1 and mark.tdt2 files store information that relates to mark thumbnails. Because these files are not particularly relevant to the present invention, they will not be discussed further.

The standardization for high-density read-only optical disks such as the Blu-ray ROM (BD-ROM) is still under way. An effective data structure for managing reproduction of video and audio data recorded on the high-density read-only optical disk such as a BD-ROM is not yet available.

3. DISCLOSURE OF INVENTION

It is an object of the present invention to provide a recording medium having a data structure for managing reproduction of video data recorded thereon, and methods and apparatuses for recording and reproducing video data on such a recording medium.

It is another object of the present invention to provide a recording medium having data structure for enabling random/shuffle reproduction of video data recorded thereon in units of playlists or designated intervals of playitems, and methods and apparatuses for recording and reproducing video data on such a recording medium.

A data structure of a recording medium for managing random/shuffle reproduction of video data recorded thereon in accordance with one embodiment of the present invention comprises title management information for at least one piece of title management information, a playlist directory area storing at least one playlist including at least one playitem, and a stream directory

area storing at least one clip of video data associated with the playlist. The title management information includes at least one segment that is associated with at least one playlist in the playlist directory area, and each playitem in the playlist is a unit to be randomized or shuffled during random/shuffle reproduction mode.

4. BRIEF DESCRIPTION OF DRAWINGS

The above features and other advantages of the present invention will be more clearly understood from the following detailed description taken in conjunction with the accompanying drawings, in which:

Fig. 1 illustrates the prior art file or data structure of a rewritable optical disk according to the Blu-ray Disc Rewritable (BD-RW) standard;

Fig. 2 illustrates an exemplary embodiment of a recording medium file or data structure according to the present invention;

Fig. 3 illustrates an example of a recording medium having the data structure of Fig. 2 stored thereon;

Fig. 4 illustrates an example of a data structure for managing an A/V clip recorded on Blu-ray ROM disk according to the present invention;

Fig. 5 illustrates an example of a file hierarchical structure for embodying the data structure of Fig. 4;

Fig. 6 illustrates a schematic diagram of an embodiment of an optical disk recording and reproduction apparatus of the present invention; and

Figs. 7 to 10 illustrate embodiments of data structures for enabling random/shuffle reproduction of an A/V clip according to the present invention.

5. MODES FOR CARRYING OUT THE INVENTION

In order that the invention may be fully understood, preferred embodiments thereof will now be described with reference to the accompanying drawings.

A high-density optical disk, for example, a Blu-Ray ROM (BD-ROM) in accordance with the invention may have a file or data structure for managing reproduction of video and audio data as shown in Fig. 2. Many aspects of the data structure according to the present invention shown in Fig. 2 are similar to that of the BD-RE standard discussed with respect to Fig 1. As such these aspects will not be described in great detail.

As shown in Fig. 2, the root directory contains at least one BD-ROM directory. The BD-ROM directory includes a general information file info.dvp, menu files menu.tidx, menu.tdt1 among others, a TITLE directory in which title management files (*.vts) are stored, a PLAYLIST directory in which playlist files (e.g., real (*.rpls) and virtual (*.vpls)) are stored, a CLIPINF directory in which clip information files (*.clpi) are stored, and a STREAM directory in which MPEG2-formatted A/V stream clip files (*.m2ts), corresponding to the clip information files, are stored.

The STREAM directory includes MPEG2-formatted A/V stream files called clips. The STREAM directory may also include a special type of clip referred to as a bridge-clip A/V stream file. A bridge-clip is used for making seamless connection between two or more presentation intervals selected in the clips, and generally have a small data size compared to the clips. The A/V stream includes source packets of video and audio data. For example, a source packet of video data includes a header and a transport packet. A source packet includes a source packet number, which is generally a sequentially assigned number that serves as an address for accessing the source packet. Transport packets include a packet identifier (PID). The PID identifies the sequence of transport packets to which a transport packet belongs. Each transport packet in the sequence will have the same PID.

The CLIPINF directory includes a clip information file associated with each A/V stream file. The clip information file indicates, among other things, the type of A/V stream associated therewith, sequence information, program information and timing information. The sequence information describes the arrival time

basis (ATC) and system time basis (STC) sequences. For example, the sequence information indicates, among other things, the number of sequences, the beginning and ending time information for each sequence, the address of the first source packet in each sequence and the PID of the transport packets in each sequence. A sequence of source packets in which the contents of a program is constant is called a program sequence. The program information indicates, among other things, the number of program sequences, the starting address for each program sequence, and the PID(s) of transport packets in a program sequence.

The timing information is referred to as characteristic point information (CPI). One form of CPI is the entry point (EP) map. The EP map maps a presentation time stamp (e.g., on an arrival time basis (ATC) and/or a system time basis (STC)) to a source packet address (i.e., source packet number).

The PLAYLIST directory includes one or more playlist files. The concept of a playlist has been introduced to promote ease of editing/assembling clips for playback. A playlist file is a collection of playing intervals in the clips. Each playing interval is referred to as a playitem. The playlist file, among other things, identifies each playitem forming the playlist, and each playitem, among other things, is a pair of IN-point and OUT-point that point to positions on a time axis of the clip (e.g., presentation time stamps on an ATC or STC basis). Expressed another way, the playlist file identifies playitems, each playitem points to a clip or portion thereof and identifies the clip information file associated with the clip. The clip information file is used, among other things, to map the playitems to the clip of source packets.

A playlist directory may include real playlists (*.rpls) and virtual playlists (*.vpls). A real playlist can only use clips and not bridge-clips. Namely, the real playlist is considered as referring to parts of clips, and therefore, conceptually considered equivalent in disk space to the referred to parts of the clips. A virtual playlist can use both clips and bridge-clips, and therefore, the conceptual considerations of a real playlist do not exist with

virtual playlists.

The info.dvp file is a general information file that provides general information for managing the reproduction of the A/V streams recorded on the optical disk. More specifically, the info.dvp file includes, among other things, a table of playlists that identifies the file names of the playlists in the PLAYLIST directory.

In addition to illustrating the data structure of the recording medium according to an embodiment of the present invention, Fig. 2 represents the areas of the recording medium. For example, the general information file is recorded in one or more general information areas, the playlist directory is recorded in one or more playlist directory areas, each playlist in a playlist directory is recorded in one or more playlist areas of the recording medium, etc. Fig. 3 illustrates an example of a recording medium having the data structure of Fig. 2 stored thereon. As shown, the recording medium includes a file system information area, a data base area and an A/V stream area. The data base area includes a general information file and playlist and title management information area and a clip information area. The general information file and playlist and title management information area have the general information file recorded in a general information file area thereof, the TITLE directory and title management information files (*.vts) recorded therein, and the PLAYLIST directory and playlist files recorded in a playlist information area thereof. The clip information area has the CLIPINFO directory and associated clip information files recorded therein. The A/V stream area has the A/V streams for the various titles recorded therein.

Video and audio data are typically organized as individual titles. A title is a logical unit for a user to recognize one playback group, for example, different movies represented by the video and audio data are organized as different titles. Furthermore, a title may be organized into individual chapters in the same way a book is often organized into chapters.

Because of the large storage capacity of the newer, high-density recording media such as BD-ROM optical disks, different

titles, various versions of a title or portions of a title may be recorded, and therefore, reproduced from the recording media. For example, video data representing different camera angles may be recorded on the recording medium. As another example, versions of title or portions thereof associated with different languages may be recorded on the recording medium. As a still further example, a director's version and a theatrical version of a title may be recorded on the recording medium. Or, an adult version, young adult version and young child version (i.e., different parental control versions) of a title or portions of a title may be recorded on the recording medium. Each version represents a different reproduction path, and the video data in these instances is referred to as multiple reproduction path video data. It will be appreciated that the above examples of multiple reproduction path video data are not limiting, and the present invention is applicable to any type or combination of types of multiple reproduction path video data. As will be described in detail below with respect to embodiments of the present invention, the data structures according to the present invention include path management information and/or navigation information for managing reproduction of multiple reproduction path video data recorded on the recording medium.

The multiple reproduction path video data can be reproduced on random/shuffle reproduction mode upon a user's request. As will be described in detail below, the data structures according to the invention may include management information and/or navigation information that enables random/shuffle reproduction mode.

The data structures according to the present invention may be applicable to the manufacturing process of a read-only disk like BD-ROM.

Fig. 4 shows a data structure for managing reproduction of multiple reproduction path video data stream that are recorded on physical data recording area in a read-only disk like BD-ROM as a plurality of A/V clip files.

One title includes at least one title segment, each title segment corresponding to one or more playlists. The playback

sequence of a title is determined among various playback sequences by setting a title segment sequence. The title segments may be written by using programs like 'Java Script'.

Each title segment is associated with a playlist. A playlist is linked to a whole or portion of a clip file. In this way, a title segment may be associated with a whole or portion of a clip file and thus multiple playback sequences of a title can be generated.

For example, a title may be a core profile for including only movie contents or a full profile including a director's cut additionally. A full profile is formed by adding the playlist corresponding to a director's cut clip to the core profile of the title. Title files of core profile and full profile may be recorded onto distinct directories. For example, the title files of the core profile are recorded in a TITLE directory while those of the full profile are recorded in a FULLTITLE directory. Or, video data of the full profile may be recorded as clip files not in a STREAM directory but in a CONTENTS directory.

A data structure for managing an A/V clip recorded on Blu-ray ROM disk according to the present invention is described below in detail with reference to an embodiment of Fig. 4. To be specific, the first title, title #1 consists of six title segments: one primary path title segment (segment 1), two branch title segments (segments 2,3), and three multi-path title segments (segments 5,6,7).

While segment 2 is associated with playlist 2 that is linked to a whole A/V stream data of clip 2, segment 3 is associated with playlist 3 that is linked to a portion of A/V stream data of clip 2.

Multi-path segments, Segments 5, 6, and 7 are associated with playlists 5, 6, and 7, respectively. Multi-path segments may be created to provide different language versions of the same presentation interval. For example, clip 3 associated with playlist 5 is a Korean language version. Clip 4 (associated with playlist 6) and clip 5 (playlist 7) may be English and Japanese versions, respectively.

Title #2 may be an auxiliary title for title #1 or another separate title. Title #2 consists of seven segments:

one primary path title segment(segment 1), three branch title segments(segments 2,3,4), and three multi-path title segments(segments 5,6,7).

A playlist may be associated with two or more title segments that belong to distinct titles.

Each title segment includes, among other things, reference information on the corresponding playlist, e.g., a filename or the playlist number, a command set including pre-commands and post-commands for the playlist, another command set including commands for playitems belonging to the playlist, and playlist attribute information like still duration.

A title management information file in accordance with the present invention will be described below in detail with reference to Fig. 5. As shown, a title management information file, '01001.vts' includes a title management information 'VTSI' that, among other things, includes a user interface application information, UIAppInfTitle and a title segment table, TableOfTitleSegment.

The title segment table includes title segments, e.g., title segments 1, 2. Each title segment includes a playlist pointer (PlayList Pointer), playlist pre-commands(PL Pre-CMDs), playlist post-commands(PL Post-CMDs), and playitem commands (PI-CMDs) for the playitems belonging to the playlist.

The playlist pointer points to one of playlist files (*.rpls or *.vpls) in a PLAYLIST subdirectory. As alluded above, the playlist pointer may be filename of the playlist file or a playlist consecutive number.

The playlist pre-command includes initial setting that is needed to execute before reproduction of an A/V clip that is linked to the playlist pointed by the playlist pointer. The playlist post-command includes post operations, for example, reset or reproduction path configuration for the subsequent reproduction that are generally required to execute after reproduction of the A/V clip linked to the playlist pointed by the playlist pointer is finished. One title segment may include a plurality set of playlist pointers,

playlist pre-commands, and playlist post-commands.

Each playitem belonging to a playlist is linked to an A/V clip file (*.m2ts) in a STREAM subdirectory based on clip information files (*.clpi) in a CLIPINF subdirectory. The linkage between playitem and clip file is illustrated in detail in Fig. 2. Once a title management file (*.vts) in a TITLE subdirectory is specified, title segments are obtained based on TableOfTitleSegment from the title management information VTSI in the specified title management file.

Each title segment is linked to at least one playlist file in a PLAYLIST subdirectory (indicated by 201 in Fig. 2). Each playitem corresponding to the playlist file is linked to clip information files (*.clpi) in a CLIPINF subdirectory (indicated by 202 in Fig. 2), each of which is associated with A/V clip files (*.mt2s) in a STREAM subdirectory (indicated by 203 in Fig. 2).

Fig. 6 illustrates a schematic diagram of an embodiment of an optical disk recording and reproducing apparatus according to the present invention. As shown, an AV encoder 9 receives and encodes audio and video data. The AV encoder 9 outputs the encoded audio and video data along with coding information and stream attribute information. A multiplexer 8 multiplexes the encoded audio and video data based on the coding information and stream attribute information to create, for example, an MPEG-2 transport stream. A source packetizer 7 packetizes the transport packets from the multiplexer 8 into source packets in accordance with the audio/video format of the optical disk. As shown in Fig. 6, the operations of the AV encoder 9, the multiplexer 8 and the source packetizer 7 are controlled by a controller 10. The controller 10 receives user input on the recording operation, and provides control information to AV encoder 9, multiplexer 8 and the source packetizer 7. For example, the controller 10 instructs the AV encoder 9 on the type of encoding to perform, instructs the multiplexer 8 on the transport stream to create, and instructs the source packetizer 7 on the source packet format. The controller 10 further controls a drive 3 to record the output from the source packetizer 7 on the optical disk.

The controller 10 also creates the navigation and management information for managing reproduction of the audio/video data being recorded on the optical disk. For example, based on information received via the user interface (e.g., instruction set saved on disk, provided over an intranet or internet by a computer system, etc.) the controller 10 controls the drive 3 to record the data structure of Figs. 2 to 5 and Fig. 5, 6, 7 or 8, that will be explained later, on the optical disk.

In the process of reproduction, the controller 10 controls the drive 3 to reproduce this data structure from the optical disk. Based on the information contained therein, as well as user input received over the user interface (e.g., control buttons on the recording and reproducing apparatus or a remote associated with the apparatus), the controller 10 controls the drive 3 to reproduce the audio/video source packets from the optical disk. For example, the user input may specify a reproduction path or a title to reproduce. This user input may be specified, for example, via a menu based graphical user interface preprogrammed into the controller 10. Using the user input and the reproduction path management information reproduced from the optical disk, the controller 10 controls the reproduction of the specified path.

For example, if a title is chosen, all title segments included in a title management information file for the chosen title are examined by the controller 10, and the user is requested which path to reproduce. If a reproduction path is selected, the controller 10 searches for A/V clip files based on the title segments related with the selected path, and reproduces the A/V clip files sequentially.

The reproduced source packets are received by a source depacketizer 4 and converted into a data stream (e.g., an MPEG-2 transport packet stream). A demultiplexer 5 demultiplexes the data stream into encoded video and audio data. An AV decoder 6 decodes the encoded video and audio data to produce the original audio and video data that was feed to the AV encoder 9. During reproduction, the controller 10 controls the operation of the source depacketizer 4, demultiplexer 5 and AV decoder 6. The controller 10 receives user

input on the reproducing operation, and provides control information to AV decoder 6, demultiplexer 5 and the source packetizer 4. For example, the controller 10 instructs the AV decoder 9 on the type of decoding to perform, instructs the demultiplexer 5 on the transport stream to demultiplex, and instructs the source depacketizer 4 on the source packet format.

While Fig. 6 has been described as a recording and reproducing apparatus, it will be understood that only a recording or only a reproducing apparatus may be provided using those portions of Fig. 6 providing the recording or reproducing function.

The processes of locating and reproducing an A/V clip file recorded on the optical disk in accordance with the present invention are described below in great detail.

After obtaining a title segment, the controller 10 accesses the corresponding playlist by referencing a playlist pointer in the title segment. Prior to reproduction, the initial setting operation is executed by using playlist pre-commands (PL Pre-CMDs) stored in the title segment. Then, the A/V clip file to reproduce is accessed by referencing one or more playitems belonging to the playlist. If the title segment includes playitem commands for the playitem being accessed, operations specified by the playitem commands are executed before reproduction of the corresponding A/V clip file. After reproduction of all of the playitems in the playlist is finished, a new title segment or a path to reproduce sequentially is identified based on the playlist post-commands (PL Post-CMDs) of the playlist. Then, the operations are executed that are required to reproduce the next title segment.

Data structures for enabling random/shuffle reproduction of an A/V clip file recorded on an optical disk according to the present invention are described below in great detail.

An embodiment of a data structure for enabling random/shuffle reproduction in units of playlists is illustrated in Fig. 7 and is described below in detail. In this embodiment, a title is referred to as a random/shuffle title.

Random/shuffle reproduction information of the title 1,

R/S_Info is stored as a portion of title management information. In the random/shuffle reproduction information, R/S_Info, random/shuffle reproduction blocks are designated in terms of a group of playlists, e.g., PlayList #n to PlayList #(n+5) or a group of title segments, e.g., Segment #k to Segment #(k+2). The k-th segment, Segment #k is associated with PlayLists #n and #(n+1), Segment #(k+1) is associated with PlayList #(n+2), and Segment #(k+2) is associated with PlayLists #(n+3), #(n+4), #(n+5).

While the disk reproducing apparatus of Fig. 6 reproduces an A/V clip file recorded on the optical disk in accordance with the data structure of Fig. 7, when the controller 10 comes to reproduce a random/shuffle reproduction block or a group of playlists that is designated as a random/shuffle block in R/S_Info, one playlist is selected randomly among the random/shuffle reproduction playlists and is then reproduced. Under random reproduction mode, upon completion of reproduction of the selected playlist, another playlist is chosen randomly again among the playlists. If shuffle reproduction mode is on, a new playlist is selected among the other playlists that have not been reproduced. In this way, a random/shuffle reproduction loop forms based on the random/shuffle reproduction information.

Fig. 7 also shows that the random/shuffle reproduction playlists, PlayList #n to #(n+5) have been reproduced in the shuffle reproduction mode in order of PlayList #n, #(n+1), #(n+4), #(n+5), #(n+2), and #(n+3). In the shuffle mode, after reproduction of all of the random/shuffle reproduction playlists is finished, the first playlist of the next title segment outside the random/shuffle reproduction loop is accessed for the subsequent reproduction. If random mode is on, after the random/shuffle reproduction playlists are reproduced repeatedly the randomly determined number of times, the first playlist of the next title segment outside the random/shuffle reproduction loop is accessed for the subsequent reproduction.

An embodiment of a data structure for enabling random/shuffle reproduction based on random/shuffle block units that are specified

and included in the title segment is illustrated in Fig. 8 and is described below in detail. In this embodiment, the title segment having random/shuffle block units is referred to as a random/shuffle title segment.

Random/shuffle reproduction information, R/S_Info may be recorded in a random/shuffle title segment, but may be recorded as a portion of the title management information as in the embodiment of Fig. 7. Information on the random/shuffle block units is included in R/S_Info. The random/shuffle title segment includes the random/shuffle block units, each of which may be defined and specified in units of playlists or playitems.

To be more specific, the random/shuffle title segment, Segment 1 includes three random/shuffle block units, RSU 1, 2, 3. While RSU 1 points to a whole PlayList #1, RSU 2 points to both the third playitem of PlayList #1, PI_13 and the first playitem of PlayList #2, PI_21. RSU 3 points to the two playitems of PlayList #2, PI_22 and PI_23.

While the disk reproducing apparatus of Fig. 6 reproduces an A/V clip file recorded on the optical disk in accordance with the data structure of Fig. 8, when the controller 10 comes to reproduce segment 1, the controller 10 chooses one of the random/shuffle block units of segment 1 randomly. A playlist or playitem pointed by the chosen random/shuffle block unit is identified and an A/V clip file is then reproduced that is linked to the playlist or playitem. Fig. 8 also shows that the random/shuffle block units have been reproduced in order of RSU 1, RSU 3, and RSU 2.

An embodiment of a data structure for enabling random/shuffle reproduction in units of playitems is illustrated in Fig. 9 and is described below in detail. In this embodiment, a title itself is designated as a random/shuffle title.

Random/shuffle reproduction information, R/S_Info may be recorded in a playlist or as a portion of the title management information as in the embodiment of Fig. 7. Random/shuffle reproduction blocks may be a group of playlists (PlayList #i, #(i+1), #(i+2) of Fig. 9) or a group of playitems. In addition,

random/shuffle reproduction blocks may be composed of only one playlist.

To be specific, PlayList #i, one of the random/shuffle reproduction playlist points to two playitems, PlayList #(i+1) points to one playitem, and PlayList #(i+2) points to three playitems.

While the disk reproducing apparatus of Fig. 6 reproduces an A/V clip file recorded on the optical disk in accordance with the data structure of Fig. 9, when the controller 10 comes to reproduce a group of random/shuffle playlists, then one playitem is chosen among all of the playitems pointed by playlists in the random/shuffle playlist group and the chosen playitem is then reproduced. For example, one playitem is selected among six playitems in the case of Fig. 9.

After reproduction of the selected playitem is finished, the next playitem is chosen randomly again from the random/shuffle playlist group. If shuffle reproduction mode is on, a new playitem is selected among the other playitems pointed by the random/shuffle playlist group that have not reproduced. In this way, a random/shuffle reproduction loop forms based on the random/shuffle reproduction information.

Fig. 9 also illustrates that, in the shuffle reproduction mode, playitems in the random/shuffle playlist group have been reproduced in order of PlayItem #1, #2 of PlayList #i, PlayItem #2, #3 of PlayList #(i+2), PlayItem #1 of PlayList #(i+1), and PlayItem #1 of PlayList #(i+2). In the shuffle mode, if reproduction of all of the playitems linked to the random/shuffle playlist group is complete, the first playlist of the next title segment outside the random/shuffle reproduction loop is ready to be reproduced.

An embodiment of a data structure for enabling random/shuffle reproduction based on random/shuffle marks is illustrated in Fig. 10 and is described below in detail.

Playlist random/shuffle reproduction information may be recorded in the corresponding playlist or as a portion of the title management information as in the embodiment of Fig. 7. The playlist

marked as a random/shuffle reproduction playlist includes information on random/shuffle marks, R/S_Mark. Random/shuffle mark information includes pointer information specifying a particular position on the A/V clip file corresponding to the playlist. In the embodiment of Fig. 10, three random/shuffle marks are stored in PlayList #1, which generate three random/shuffle reproduction intervals. In this embodiment, the start position of the A/V clip should be marked by a random/shuffle mark.

When the disk reproducing apparatus of Fig. 6 reproduces a random/shuffle playlist or PlayList #1 of the title recorded on the optical disk in accordance with the data structure of Fig. 10, the controller 10 chooses one of the random/shuffle marks among the random/shuffle mark group, and reproduces an interval between the chosen mark and the following random/shuffle mark on the corresponding A/V clip. Upon completion of reproduction of the interval, another random/shuffle mark is selected randomly again in the random mode. If shuffle mode is on, a new one is selected among the other random/shuffle marks that have not been chosen. Then, a portion of the A/V clip from the newly chosen mark to the following mark is reproduced. And then, the next random/shuffle mark is chosen again. Fig. 10 also illustrates a playback sequence generated by the selection order of the random/shuffle marks, e.g., R/S_Mark #1, #3, and #2.

The present invention, disclosed with respect to a limited number of embodiments, provides a greater level of flexibility in the random/shuffle reproduction of video data than previously available.

While the invention has been disclosed with respect to a limited number of embodiments, those skilled in the art, having the benefit of this disclosure, will appreciated numerous modifications and variations therefrom. It is intended that all such modifications and variations fall within the spirit and scope of the invention.